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PACKAGE QUALIFICATION SUMMARY REPORT

Purpose: To provide qualification summary

Products: Silicon Photomultiplier KETEK SiPM PM33-WB-series (BGA package)

Updated: January 22, 2019

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2) RELIABILITY TEST DESCRIPTIONS

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1 Qualification Overview

The purpose of this report is to summarize qualification test procedures and results of the Silicon Photomultiplier SiPM PM33-WB series. The tests were done for KETEK at the Electronic Packaging and Sensor Lab of the University of Applied Sciences Munich.

2 Reliability Test Description

The reliability tests were performed according to the following qualification plan set by KETEK. Standard conditions for the use of the devices were assumed when the test conditions were defined.

MSL1 classification and pre-conditioning was performed before all tests. The devices were classified as good in case of an electrical connection between BGA and chip (verified by a diode test). Optical inspection was done after each diode test.

In addition the spectroscopic performance (DCR, CTP, PDE@406nm) of 24pcs devices was investigated after reliability testing (MSL1; 250x @ -40°C/+85°C; 250h @ 85°C/85%RH; 250h @ 125°C) to verify that only the package is affected by the applied reliability testing, but not the silicon chip itself.

Test	Method	Test Conditions	Qty	Target
PC	Pre-conditioning / MSL classification according to J-STD-020	MSL1 SAM inspection was replaced by optical inspection	246	0 failed parts
TC	Temperature Cycling according to JESD22-A104	1000x @ -40°C/85°C without bias 1000x @ -55°C/125°C without bias	30 130	0 failed parts
H^3TS	High Humidity High Temperature Storage according to JESD22-A101	1000h @ 85°C/85% RH without bias	120	0 failed parts
HTS	High Temperature Storage according to JESD22-A103	1000h @ 125°C without bias	120	0 failed parts
Combined Test	Temperature Cycling, High Humidity High Temperature Storage and High Temperature Storage	250x @ -40°C/85°C 250h @ 85°C/85% RH 250h @ 125°C	24	0 failed parts

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ESD	ESD Test using human-body model	4000 V, 3 Pulses with positive and negative polarity each	30	0 failed parts
HTRB	High Temperature Reverse Bias	1000 h @ 85 °C, 30 V reverse Bias, no Light	32	0 failed parts
H^{3}TRB	High Humidity High Temperature Reverse Bias	1000 h @ 85 °C, 85 % R.H. 30 V reverse Bias, no Light	32	0 failed parts

3 Qualification Results

MSL Pre-conditioning

Results:

Test-condition	**Devices tested**	**Date**	**Quantity**	**Result**
MSL1	PM3315-WB-A0	01 / 2017	9	All passed
	PM3325-WB-A0		9	All passed
	PM3315-WB-A0		3	All passed
	PM3325-WB-A0		3	All passed
	PM3325-WB-A0	01 / 2017	30	All passed
	PM3325-WB-A0	03 / 2017	24	All passed Spectroscopic performance was verified after test
	PM3325-WB-A0	03 / 2017	25	All passed
	PM3325-WB-A0	03 / 2017	25	All passed
	PM3315-WB-A0	07 / 2017	25	All passed
	PM3325-WB-B0	01 / 2018	45	All passed
	PM3325-WB-D0	10/2018	48	All passed

Temperature Cycling

Results:

Test-condition	Devices tested	Date	Quantity	Result
MSL1 pre-conditioning 1000x -40°C/+85°C	PM3325-WB-A0	03 / 2017	30	All passed
MSL1 pre-conditioning 1000x -55°C/+125°C	PM3315-WB-A0	09 / 2017	25	All passed
MSL1 pre-conditioning 1000x -55°C/+125°C	PM3325-WB-A0	09 / 2017	25	All passed
MSL1 pre-conditioning 500x -55°C/+125°C	PM3325-WB-A0	01 / 2018	15	All passed
1000x -55°C/+125°C	PA3325-WB-B0-A0-0808	01 / 2018	64 (on Array)	All passed
MSL1 pre-conditioning 1000x -55°C/+125°C	PM3325-WB-D0	10 /2018	16	All passed

Mechanical Stability

Results:

The shear force and pulling force needed to disassemble the devices soldered to PCB was measured. The recommended soldering temperature profile, footprint and solder paste specified in the PM33-WB-series datasheet have been used.
Mean shear force after soldering: 40.5 N; standard deviation: 2.5 N
Mean pulling force after soldering: 34.7 N; standard deviation: 4.3 N

High Temperature Storage

Results:

Test-condition	Devices tested	Date	Quantity	Result
MSL1 pre-conditioning 1000h @ 125°C	PM3325-WB-A0	05 / 2017	25	All passed
MSL1 pre-conditioning 1000h @ 125°C	PM3325-WB-B0	01 / 2018	15	All passed
1000h @ 125°C	PA3325-WB-B0-A0-0808	01 / 2018	64 (on Array)	All passed

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MSL1 pre-conditioning 1000h @ 125°C	PM3325-WB-D0	10 /2018	16	All passed

High Humidity High Temperature Storage

Results:

Test-condition	Devices tested	Date	Quantity	Result
MSL1 pre-conditioning 1000h @ 85°C/85% RH	PM3325-WB-A0	05 / 2017	25	All passed
MSL1 pre-conditioning 1000h @ 85°C/85% RH	PM3325-WB-B0	01 / 2018	15	All passed
1000h @ 85°C/85% RH	PA3325-WB-B0-A0-0808	01 / 2018	64 (on Array)	All passed
MSL1 pre-conditioning 1000h @ 85°C/85% RH	PM3325-WB-D0	10 /2018	16	All passed

High Temperature Reverse Bias

Results:

Test-condition	Devices tested	Date	Quantity	Result
1000 h @ 85 °C, 30 V, reverse Bias, no Light	PM3325-WB-D0	11 / 2018	6	All passed
1000 h @ 85 °C, 30 V, reverse Bias, no Light	PM3325-WB-D0	01 / 2019	26	All passed

High Humidity High Temperature Reverse Bias

Results:

Test-condition	Devices tested	Date	Quantity	Result
1000 h @ 85 °C, 85 % R.H., 30 V reverse Bias, no Light	PM3325-WB-D0	11 / 2018	6	All passed
1000 h @ 85 °C, 85 % R.H., 30 V reverse Bias, no Light	PM3325-WB-D0	01 / 2019	26	All passed

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Combined Test

Results:

Test-condition	Devices tested	Date	Quantity	Result
MSL1 pre-conditioning 250h @ -40°C/+85°C 250h @ 85°C/85% RH 250h @ 125°C	PM3325-WB-A0	05 / 2017	24	All passed Spectroscopic performance was verified after test

ESD

Results:

Test-condition	Devices tested	Date	Quantity	Result
3 Pulses of each polarity @ 4000 V	PM3350-WB-A0	04 / 2018	10	All passed.
3 Pulses of each polarity @ 4000 V	PM3315-WB-B0	04 / 2018	10	All passed.
3 Pulses of each polarity @ 4000 V	PM3325-WB-B0	04 / 2018	10	All passed.

4 Conclusion

The devices PM33xx-WB did pass the required reliability test conditions so they should withstand standard conditions for the use of electronic components.

If the devices are used under special conditions, additional tests should be defined.

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